Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/US05/008777

International filing date: 16 March 2005 (16.03.2005)

Document type: Certified copy of priority document

Document details: Country/Office: US
Number: 60/553,692
Filing date: 16 March 2004 (16.03.2004)

Date of receipt at the International Bureau: 25 April 2005 (25.04.2005)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)

1307369

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

April 12, 2005

THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A FILING DATE.

APPLICATION NUMBER: *60/553,692*
FILING DATE: *March 16, 2004*
RELATED PCT APPLICATION NUMBER: *PCT/US05/08777*

UNITED STATES PATENT AND TRADEMARK OFFICE · DEPARTMENT OF COMMERCE

Certified by

Jon W. Dudas

Under Secretary of Commerce
for Intellectual Property
and Director of the United States
Patent and Trademark Office

PTO/SB/16 (01-04)
Approved for use through 07/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. EV 418 886 414 US

INVENTOR(S)

Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Douglas Allan	Curtis	143 Denlon Lane Troutman, North Carolina 28166 USA

Additional inventors are being named on the ______ *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

PUMP SEALING APPARATUS

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

☑ Customer Number: 23638

OR

☐ Firm or Individual Name					
Address					
Address					
City		State		Zip	
Country		Telephone		Fax	

ENCLOSED APPLICATION PARTS ***(check all that apply)***

☑ Specification *Number of Pages* 8
☐ CD(s), Number ______
☑ Drawing(s) *Number of Sheets* 5
☐ Other (specify) ______
☑ Application Data Sheet. See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

☑ Applicant claims small entity status. See 37 CFR 1.27.
☐ A check or money order is enclosed to cover the filing fees.
☑ The Director is herby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 01-0265
☐ Payment by credit card. Form PTO-2038 is attached.

FILING FEE Amount ($): $ 80.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☑ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: ______

Respectfully submitted,

SIGNATURE Jonathan M. Hines

Date March 16, 2004

TYPED or PRINTED NAME Jonathan M. Hines

REGISTRATION NO. 44,764
(if appropriate)
Docket Number: 2974/6

TELEPHONE 704-375-9249

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

PUMP SEALING APPARATUS

BACKGROUND OF THE INVENTION

[0001] This invention relates generally to pumps and more particularly to a diaphragm pump. Diaphragm pumps are assembled with multiple components creating joints that must be sealed in order to insure a leak free condition. Current diaphragm pump sealing technology typically has not produced pumps that are leak free under all conditions.

[0002] There are two primary joints that must be considered in evaluating leaks in miniature diaphragm pumps. The first is the seal joint around the perimeter of the diaphragm created when the diaphragm is sandwiched between the pump head, generally an assembly of multiple components, and the pump body. This seal joint is both a seal and a clamping point to secure the diaphragm in place during operation of the pump. Therefore, if a good seal is present but the diaphragm is not properly clamped, a shift in the diaphragm due to the operation of the pump could likely cause a failure in the sealing. The second seal area is that between the components that house the pump valves. This is normally a split in the pump head creating an upper component typically referred to as the "head" and a lower component typically referred to as the "chamber". There are several methods currently used to create a seal at this joint ranging from gaskets that are integrated with the valve(s) to separate gaskets that surround the valve sections of the joint.

[0003] Current technologies used for these joints have historically not been successful in maintaining a leak free pump under all conditions the pump may be subjected to. These conditions include higher pressures, extremely viscous fluids, fluids with very low surface tension, and extreme thermal variations, among others. Accordingly, there is a need for a diaphragm pump having robust sealing.

BRIEF SUMMARY OF THE INVENTION

[0004] The above-mentioned need is met by the present invention, which provides a diaphragm pump with an O-ring beaded gasket and a diaphragm with a combined sealing and clamping feature.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] The subject matter that is regarded as the invention may be best understood by reference to the following description taken in conjunction with the accompanying drawing figures in which:

[0006] Figure 1 is a top view of a diaphragm pump constructed in accordance with the present invention;

[0007] Figure 2 is a view taken along lines 2-2 of Figure 1;

[0008] Figure 3 is a top view of a pump diaphragm constructed in accordance with the present invention;

[0009] Figure 4 is a view taken along lines 4-4 of Figure 3;

[0010] Figure 5 is an enlarged view of a portion of the diaphragm of Figure 4;

[0011] Figure 6 is a top view of a gasket constructed in accordance with the present invention;

[0012] Figure 7 is a view taken along lines 7-7 of Figure 6;

[0013] Figure 8 is an enlarged view of a portion of the gasket of Figure 7;

[0014] Figure 9 is an enlarged sectional view of a portion of the pump of Figure 1, showing a gasket installed therein;

[0015] Figure 10 is an enlarged sectional view of a portion of the pump of Figure 1, showing a diaphragm installed therein; and

[0016] Figure 11 is an enlarged sectional view of a portion of a pump chamber and body, showing an alternative embodiment of a diaphragm installed therein.

DETAILED DESCRIPTION OF THE INVENTION

[0017] Referring to the drawings wherein identical reference numerals denote the same elements throughout the various views, Figure 1 illustrates an exemplary diaphragm pump 10 constructed in accordance with the present invention. A head 12 is attached to a chamber 14. The head 12 and the chamber 14 are referred to collectively as a pump head 16. The joint between the head 12 and the chamber 14 is sealed with a gasket 18. A pump body 20 is attached to the lower end of the pump head 16. A flexible diaphragm 22 is disposed between the pump head 16 and the body 20. The diaphragm 22 is the primary working part of the pump 10, and also seals the joint between the pump head 16 and the chamber 14, thus forming a working space 24. The diaphragm 22 is connected to a source of motive power such as an electric motor through a suitable connection, for example by the crank arm and cam assembly 26 illustrated. An inlet passage 28 is formed in the pump head 16 extending from an inlet port 30 through an inlet valve pocket 32 to the working space 24. An outlet passage 34 is formed in the pump head extending from the working space 24 through an outlet valve pocket 36 to an outlet port 38.

[0018] Figures 3, 4, and 5 illustrate the diaphragm 22 in more detail. The diaphragm 22 is constructed of a flexible, leakproof material. Any material which resists the expected fluids to be pumped and having the proper resiliency may be used.

Examples of suitable materials include ethylene propylene diene terpolymer (EPDM) or VITON fluoroelastomer material. The diaphragm 22 has a generally cylindrical centrally-positioned stem 40 and a disk-shaped head 42, the upper surface of which forms the face 44 of the diaphragm 22. A central bore 46 is formed in the stem 40. An upstanding bead 48, which is shown in more detail in Figure 5, is formed at the outer circumferential edge 50 of the diaphragm 22. The bead 48 comprises a flat, axially-facing surface 52 which is flanked by an outer angled surface 54 which faces radially outward, and an inner angled surface 56 which faces radially inward. Each of the angled surfaces 54 and 56 is disposed at an angle "A" measured from a reference line parallel to the longitudinal axis "L" of the diaphragm 22.

[0019] Figure 10 illustrates how the diaphragm 22 is mounted between the body 20 and the pump chamber 14. The chamber 14 includes a circumferentially extending wedge-shaped pocket 58 around its periphery that accepts the bead 48 of the diaphragm 22. The pocket 58 is generally the same cross-sectional shape as the bead 48 and includes an axially facing surface 60 flanked by first and second angled surfaces 62 and 64. The pocket 58 is disposed such that the centerline "B" of the bead 48 on the diaphragm 22 coincides with the centerline "P" of the pocket 58. However, the dimensional relation between the bead 48 on the diaphragm 22 and the pocket 58 in the chamber 14 is such that when fully assembled there is a predetermined interference between the pocket 58 and the bead 48, compressing the bead 48 and forming a primary joint 66.

[0020] This interference causes a certain amount of compression force against each angled surface 54 and 56 of the bead 48. This compression forms a seal between the angled surfaces 54 and 56 of the diaphragm 22 and the contacting surfaces 62 and 64 of the chamber 14. Because the materials used in the diaphragm 22 are essentially incompressible, the pocket 58 in the chamber 14 has a depth greater than the height of the bead 48 which allows for the displacement of the bead material being compressed in the primary joint 66. In Figure 10, the compressed shape of the diaphragm 22 is

shown in solid lines, while the free shape of the diaphragm 22 is shown by the dashed line labeled "FD".

[0021] The symmetrically tapered design of the primary joint 66 creates two sealing surfaces with equal forces being applied to both sides. Because the resultant forces have both a horizontal vector (i.e. radially oriented relative to the pump centerline L) and a vertical vector (i.e. parallel to the pump centerline L), the primary joint 66 acts as both a sealing feature, preventing leaking between the chamber 14 and the body 20, and as a clamping feature, retaining the diaphragm 22 in place. The angle "A" may vary from about 10° to about 30°. Angles much less than about 10° begin to lose the vertical vector needed for an efficient clamping action. Angles much greater than about 30° will begin to lose the horizontal vector needed to create a robust sealing action. In the illustrated example, the angle "A" is about 15°.

[0022] The amount of interference is determined in part by the angle designed into the bead 48, the type of material used for the diaphragm 22 and the design of the diaphragm 22, including but not limited to its thickness and overall diameter. The illustrated design uses an amount of interference that equates to an overall compression rate of approximately 22%, however rates from about 16% to about 40% may be used. While the upper end of this range equates to what is considered an industry standard in an O-ring face seal condition, the tapered design of the bead 48 allows the low end of the compression rate to drop to a lower level and still retain excellent sealing and clamping characteristics

[0023] In addition to the clamping action provided by the joint of the pocket 58 and bead 48, a compression force is applied to a small parallel-sided flat 68 of the diaphragm 22 disposed directly adjacent to the inner angled surface 56 of the bead 48. This width "W" of this flat 68 can be as large as practical but should be no smaller than about 0.38 mm (.015 in.) Exemplary values for the width W range from about 0.38 mm (.015 in.) to about 0.51 mm (.020 in.) This width is sufficient for use with a diaphragm

about 2.54 cm (1 in.) in diameter. Larger diaphragms would likely need some increase in the width of this flat 68. The flat 68 is clamped between a circumferential upper rim 70 formed in the chamber 14, and a circumferential lower rim 72 formed in the body 20 which is bounded by a V-groove 74. The amount of compression on the flat 68 will be lower than that used in a prior art "face seal" design as the design of the pump 10 intentionally allows very little room for the displacement for the diaphragm 22 in this area. The illustrated example uses a compression rate of about 13.5%. However, depending on the overall design, compression rates of about 10% to about 25% would be appropriate for this clamping feature.

[0024] As an alternative, shown in Figure 11, a diaphragm 122 having a flat 168 disposed radially outward of a bead 148 could be used between a chamber 114 and a body 120. With this embodiment, an area 76 could be supplied to capture further elastomer displacement. With this displacement accounted for, higher compression rates could easily be applied, for example upwards of 30% or 40%.

[0025] The flat 68 is not intended to be a primary sealing or clamping feature but is used as a secondary clamping feature that isolates the movement of the diaphragm 22 from the primary joint 66. This eliminates the potential for movement between the angled surfaces 54 and 56 of the diaphragm 22 and the mating surfaces 62 and 64 of the chamber 14 that create the tapered primary joint 66. By doing this, a permanent and secure joint is made between the diaphragm 22 and the chamber 14. There is also a benefit for the assembly process with this design. The tapered shapes of the bead 48 and the pocket 58 drive the diaphragm 22 into a true concentric position within the chamber 14 thus preventing misalignment of the diaphragm 22 during assembly. With a prior flat diaphragm or diaphragm having a straight sided bead, this benefit does not present itself.

[0026] Even though there will be tolerance stack-ups between the centerline diameter of the bead 48 and the pocket 58, the tapered joint design is forgiving enough

to compensate for any expected variations between these two features. If, for example, the centerline diameter of the bead 48 (measured at line "B") was 0.254 mm (.010 in.) larger or smaller than the centerline diameter of the pocket 58 (measured at line "P"), the bead 48 will still begin alignment into the pocket 58 during assembly and be either pulled radially outward or pushed radially inward respectively, forcing the components to seat together as intended.

[0027] Turning now to Figures 6-9, the gasket 18 is illustrated in more detail. The gasket 18 is constructed of a flexible, leakproof material. Any material which resists the expected fluids to be pumped and having the proper resiliency may be used. Examples of suitable materials include ethylene propylene diene terpolymer (EPDM) or VITON fluoroelastomer material. The gasket 18 is a continuous member including a flat web 78 and a pair of spaced-apart circular section beads 80 and 82, having a diameter D. If desired, only one bead, or multiple beads could be used In plan view the gasket 18 is patterned so that the beads 80 and 82 surround the perimeter of the area or areas to be sealed. In the particular example illustrated the gasket 18 includes two generally rectangular areas 84 and 86.

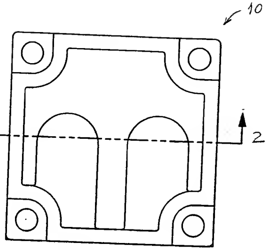
[0028] Figure 9 illustrates how the gasket 18 is mounted between the head 12 and the chamber 14. The gasket 18 is received between a planar lower surface 88 of the head 12 and a groove 90 formed in the upper surface 92 of the chamber 14, which cooperatively define a gland 94. The dimensions of the gland 94 are chosen such that when fully assembled there is a predetermined interference between the gland 94 and the gasket beads 80 and 82, forming a seal. In Figure 9 the compressed shape of the gasket 18 is shown in solid lines, while the free shape is shown in dashed lines marked "FG". Because this seal is a permanent static seal it has been found that high compression of the gasket beads 80 and 82 can be applied without adverse consequences. Because of the design of the gland 94, there is adequate space for the deformation of the gasket 18 under high compression conditions.

[0029] The prior art recommended range of compression on a static O-ring face seal is about 20% to about 40%. This typical range of static compression works well, but if needed, compression amounts of up to about 50% or 60% can be applied to the gasket beads 80 and 82. This is a benefit when working with plastic parts molded with certain advanced engineered resins. Some of these plastic materials have a tendency to exhibit distorted post-molding conditions such as sinking or warping which will in effect cause the depth of the gland 94 to vary. The smaller the nominal depth of the gland 94, the more effect a given amount of distortion will have. Though these plastic distortions are never desirable, they are inherent when working with plastic injection molded parts, especially when working with some of the materials required for certain compatibility properties or other physical characteristics.

[0030] For example, the gland 94 might have nominal depth D of 0.89 mm (.035 in.) A typical O-ring design allowing for a 35% compression ratio would have a nominal diameter of 1.37 mm (.054 in.) If both the head 12 and chamber 14 have a degree of sinking and/or warping that combine to add 0.20 mm (.008 in.) to some areas of the gland 94, it would be desirable to allow for the 35% compression rate at the greatest depth of 1.09 mm (.043 in.) Therefore an O-ring diameter "O" of 1.68 mm (.066 in.) could be used for the gasket beads 80 and 82. This would then create a compression of 47% where the gland depth D was only 0.89 mm (.035 in.) While this is a higher compression rate than is considered within the industry acceptable range, the present design allows the higher compression to work effectively to seal this joint.

[0031] The foregoing has described a diaphragm pump having a unique sealing arrangement. While specific embodiments of the present invention have been described, it will be apparent to those skilled in the art that various modifications thereto can be made without departing from the spirit and scope of the invention. Accordingly, the foregoing description of the preferred embodiment of the invention and the best mode for practicing the invention are provided for the purpose of illustration only and not for the purpose of limitation.

FIG. 1



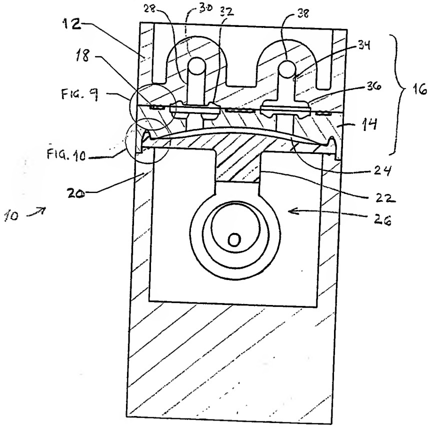


FIG. 2

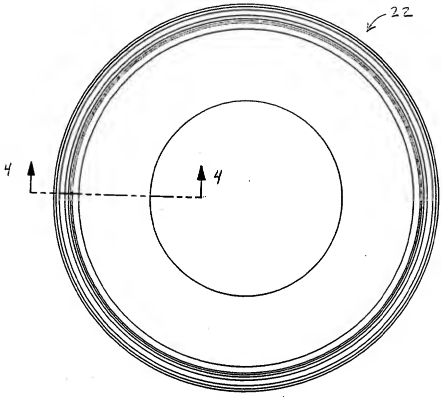


FIG. 3

FIG. 4

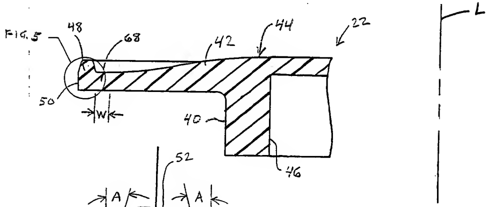
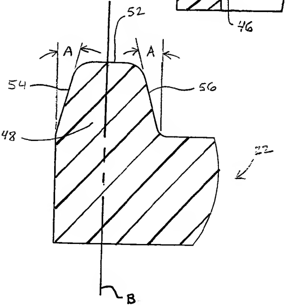


FIG. 5



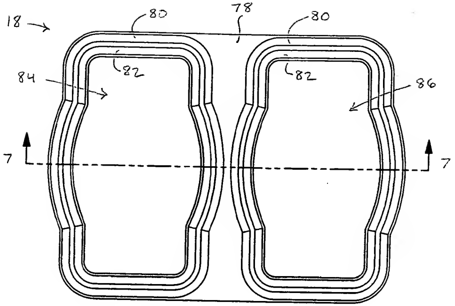


FIG. 6

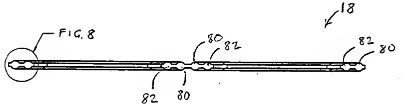


FIG. 7

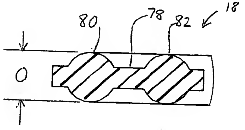


FIG. 8

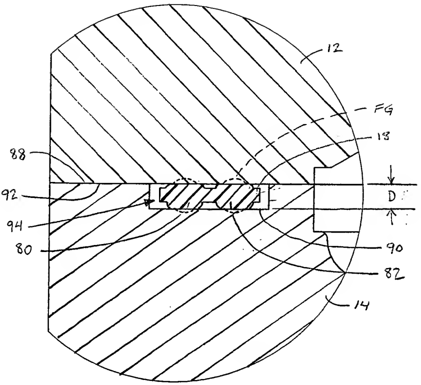

12
FG
18
88
92
D
94
80
90
82
14

FIG. 9

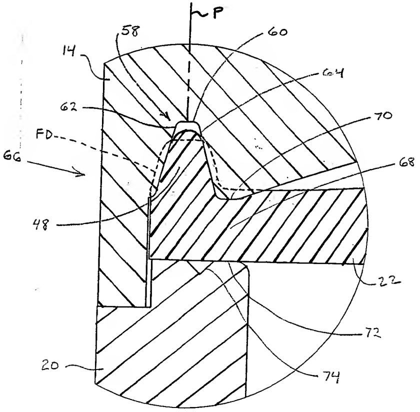

P
58
60
14
64
62
70
FD
68
66
48
22
72
20
74

FIG. 10

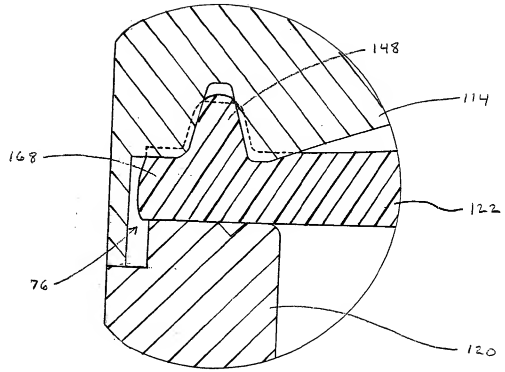


FIG. 11

Application Data Sheet

Inventor Information

Inventor One Given Name::	Douglas Allan
Family Name::	Curtis
Postal Address Line One::	143 Denlon Lane
City::	Troutman
State or Province::	North Carolina
Postal or Zip Code::	28166
Country::	USA
Citizenship::	USA

Correspondence Information

Name Line One::	Adams Evans P.A.
Address Line One::	2180 Two Wachovia Center
City::	Charlotte
State or Province::	North Carolina
Postal or Zip Code::	28282
Telephone::	(704) 375-9249
Facsimile::	(704) 375-0729
Email::	jmh@adamspat.com

Application Information

Title Line One::	PUMP SEALING APPARATUS
Total Drawing Sheets::	5
Formal Drawings?::	No
Application Type::	Provisional

Representative Information

Registration Number One::	29,037
Registration Number Two::	47,394
Registration Number Three::	44,764
Registration Number Four::	53,702